



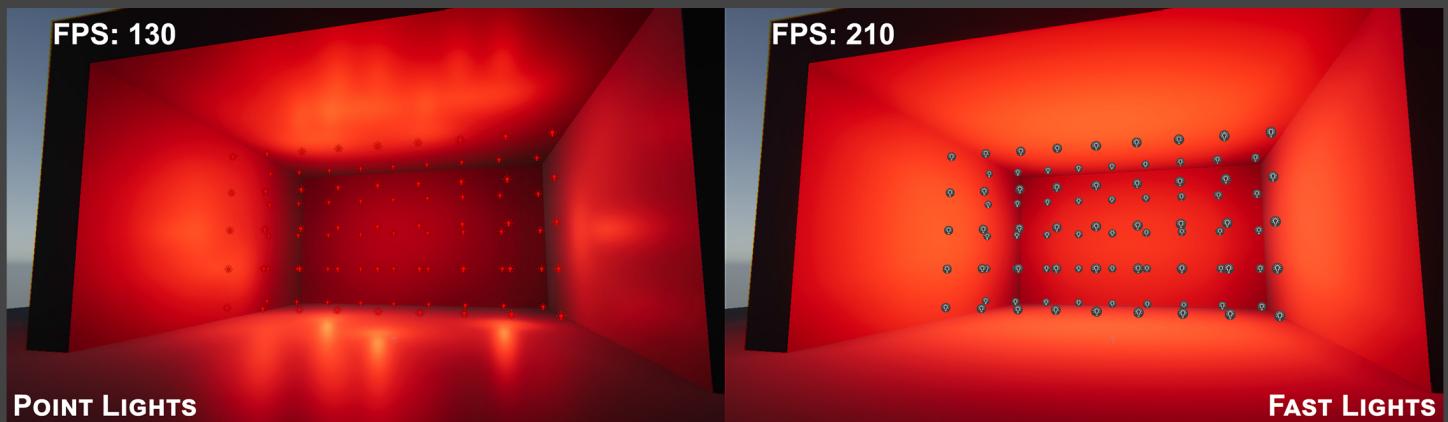
Developers Guide v2.0

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Introduction

UPGEN Lighting is an optimized for maximum performance framework that aspires to provide a fully dynamic approximation of Global Illumination to your games (requires no precomputations). This solution provides high execution speed, produces great visual results, and uses a minimum of system resources. Emulation of indirect lighting could be made as fully automatic, in a semi-automatic way, or by manual designing light to save extra performance.

Under the hood, the solution is based on the idea of making an ultra-fast type of point light sources (10 times faster than standard ones) and using thousands of them to approximate light propagation for the scene in realtime. To achieve this we made a special kind of screen space effect, which bakes each frame hundreds of most valuable lights and applies combined lighting inside G-Buffer for the current camera.



This framework provides several workflows for building lighting in your scenes. You can use such Fast Light sources to automatically transfer bounced light from standard light sources using Ray-Tracing. Or you can combine a standard type of light sources with Fast Lights to manually approximate GI in complex scenes and achieve the best performance and a beautiful visual look.

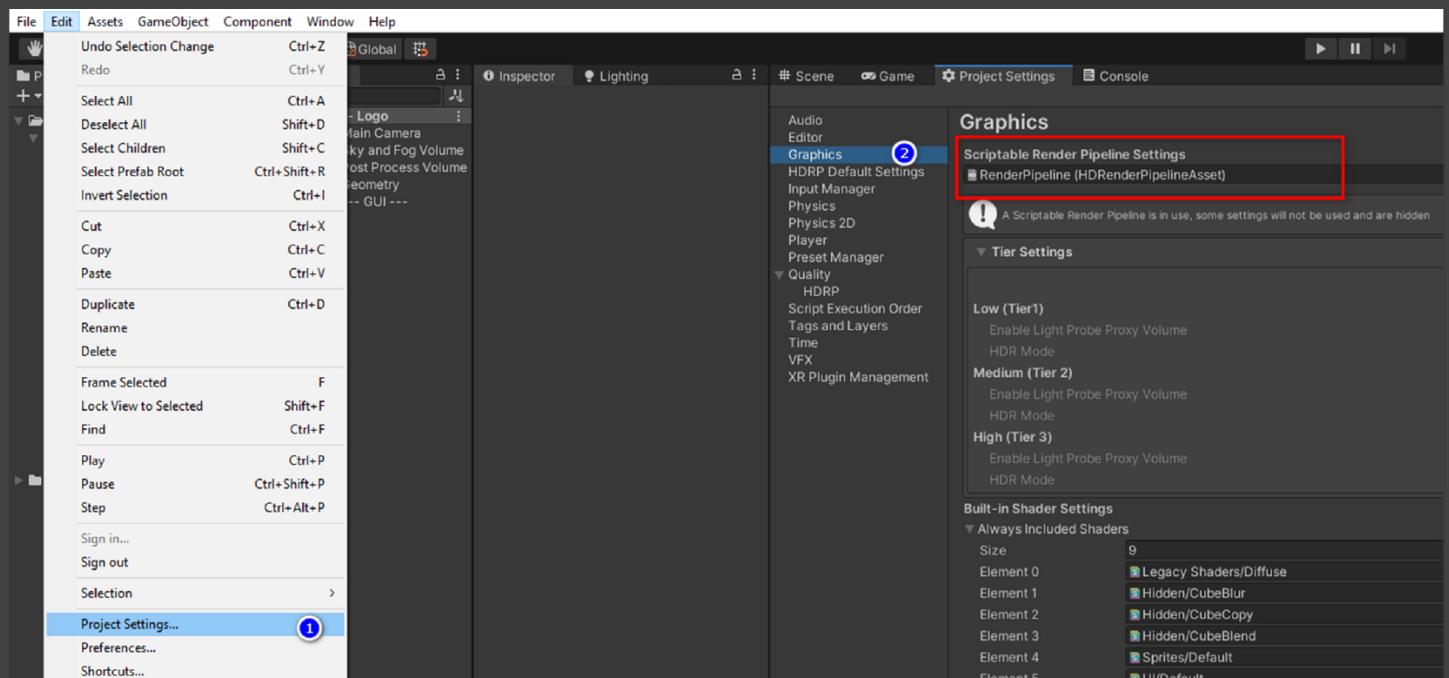


Installation

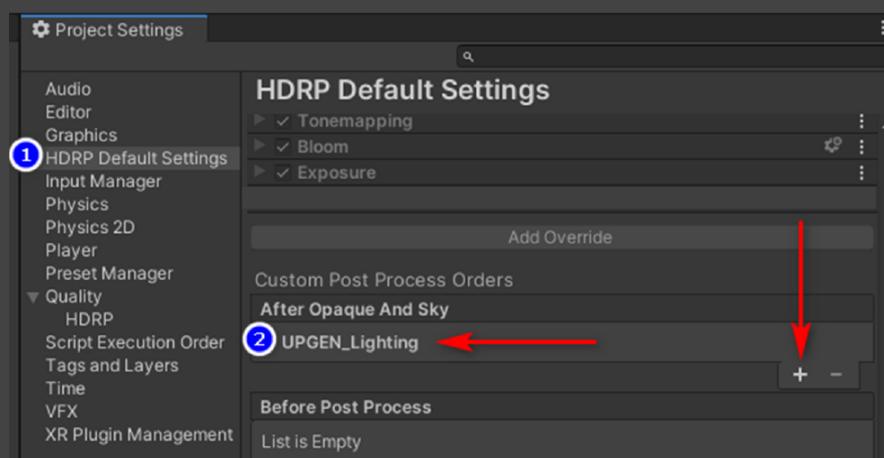
Step 1. Go to AssetStore, download, and import **UPGEN Lighting** package. The first time you should use a temporary or an empty project for installation to guarantee that you will not break your main project files or settings.

Step 2. Go to Project Setting in the «Graphics» category. Specify as Scriptable Render Pipeline Settings any HDRP-based asset. You can create your own or just use one from examples folder:

Assets | UPGEN | Lighting | Examples | Settings | RenderPipeline.asset



Step 3. Go to Project Settings in the «HDRP Default Settings» category. Add UPGEN Lighting post-effect to the custom post process stack in the section called «**After Opaque And Sky**».

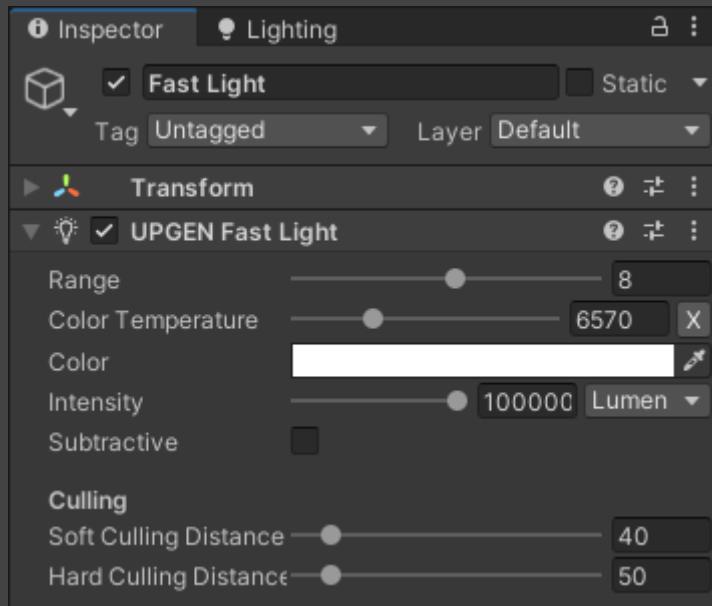


Step 4. Add «**UPGEN_Lighting**» post effect to the profile of some global volume in your scene and set effect intensity to 1.

Step 5. Ensure that you are using Linear Color Space. To do this go to Project Settings in the «Player» category, «Other Settings» section, «Color Space» property.

Fast Light

Fast Light. It produces a single light source for post processing and is designed to be a cheap alternative to Point Light. That is why all its properties are similar to base one.



* **Color Temperature.** The color temperature of the electromagnetic radiation emitted from an ideal black body is defined as its surface temperature in kelvin. White is 6500K according to the D65 standard. Candle light is 1800K.

* **Color.** Just the color of the emitted light multiplied with the temperature.

* **Intensity.** Set the brightness of the light. Multiplied by color it gives the final lighting amount.

* **Range.** Define how far the light emitted from the center of the object.

* **Subtractive.** All lighting from this Fast Light will be subtracted from the final result of screen pixel. This could be used to remove unwanted leaking artefacts in some areas or to create darkness visual effect.

* **Soft Culling Distance.** If distance from current camera to light is greater than this - will be applied soft fading of Fast Light.

* **Hard Culling Distance.** If distance from current camera to light is greater than this - Fast Light will be ignored.

Fast Light - Best Practices

Rule - any emission should be reinforced by Fast Light.

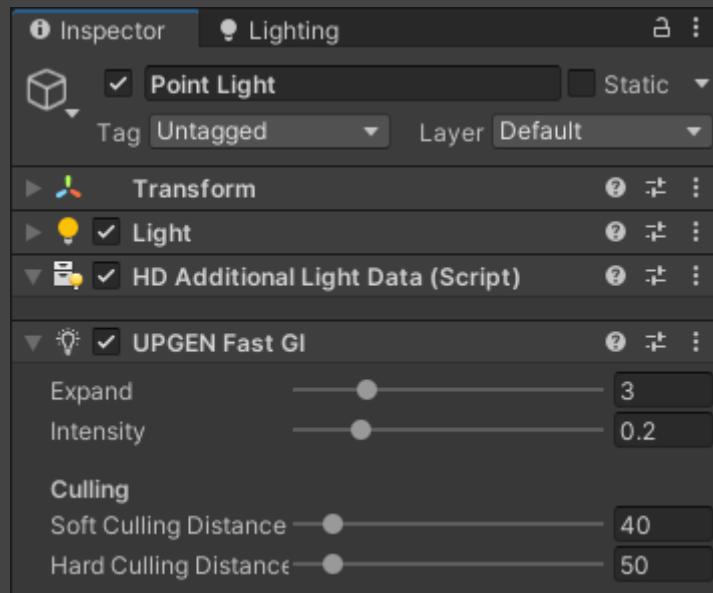
In our game the main rule is simple - even every tiny emission source like a light-emitting diode that's present on the texture of an object should emit a real light. So when the player puts his/her hand or any other object near to this light source he/she should see the lighting coming from it. So literally every texture part of the object with emission or small emissive objects could/should have corresponding Fast Lights.

Take a look at this facade of Santa's House (in the image below). Each small Christmas light here has its own Fast Light so we could have hundreds of them in a single frame when the player is looking on the facade. However, players can come closer, inspect each one, and see that all these lights are really emitting lighting, and are not just present as emissive materials or lightmaps.



Fast GI

Fast GI. It is a cheap addition to the basic light component. It takes in realtime all properties of basic light to add one big Fast Light around which it will fake indirect lighting. It supports only Point and Spot types of basic light and does nothing for Directional and Area lights.

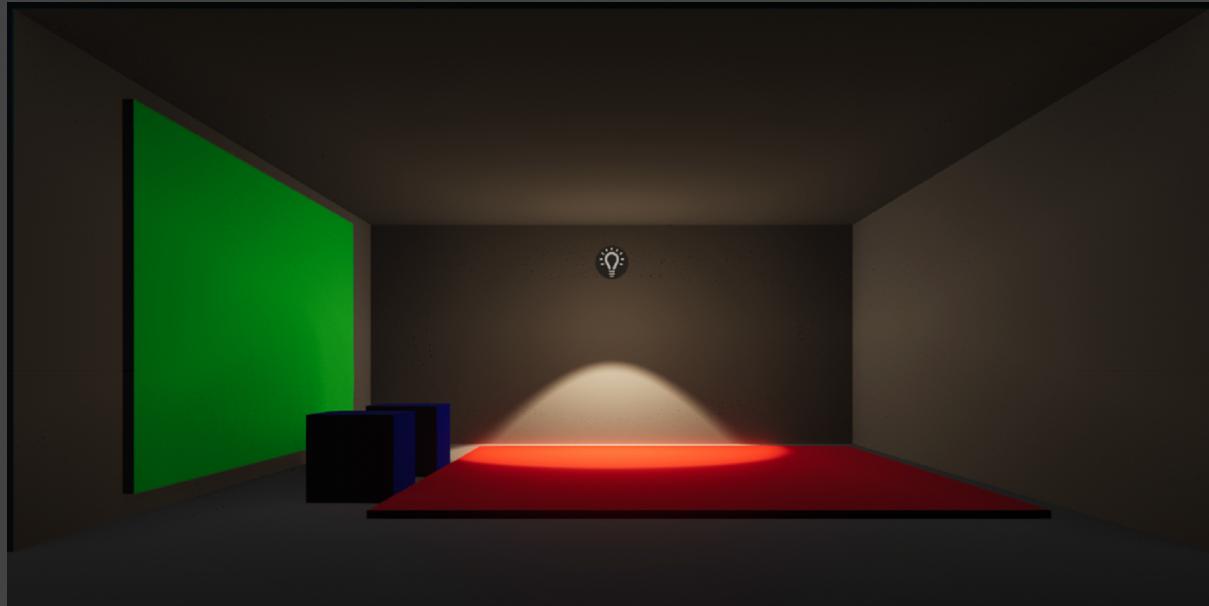


* **Expand.** Multiplier - represents how big Fast Light will be (around Point Light or the first part of the cone for Spot Light). Value 1 means range equals to base light range. Value 3 means 300% or 3 times bigger range than base light has.

* **Intensity.** Multiplier - represents a percent of intensity that will be taken by Fast Light from basic light. Value 1 means 100% or the same intensity as base light has.

* **Soft Culling Distance.** If distance from current camera to light is greater than this - will be applied soft fading of Fast Light and basic light itself.

* **Hard Culling Distance.** If distance from current camera to light is greater than this - Fast Light and basic light itself will be fully disabled.



Fast GI - Best Practices

Rule - Point Light should go along with Fast Light.

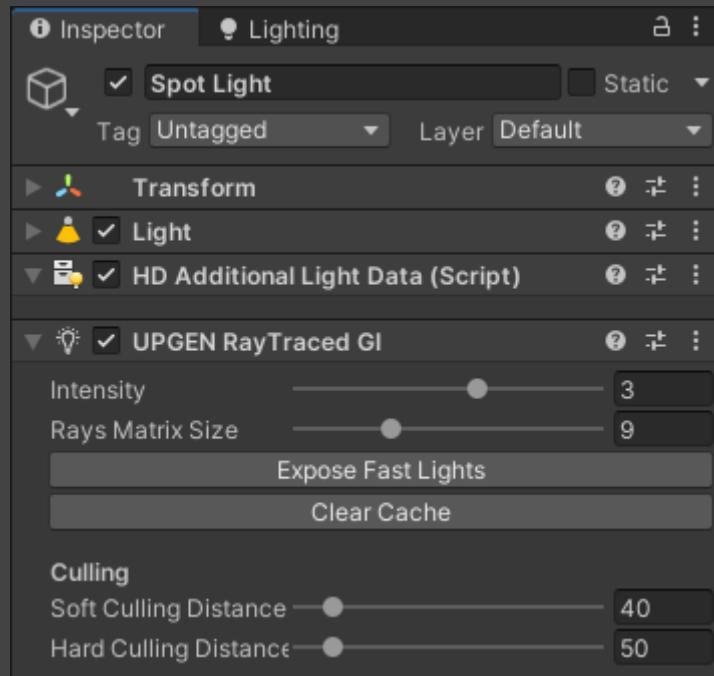
Any small lamp or a candle should have a small (1-2 meters) and intense Point/Spot Light to make a shiny specular highlight on the objects in a small radius around and it should also have a big Fast Light, which will fake indirect lighting from it in the whole room. Fast Light should be 3-4 times bigger in range than basic Point Light and 10-15 times less intensive.

This approach could be easily implemented by attaching the Fast GI component to your basic light. However, you could create two light sources separately - first with Point/Spot Light somewhere in the room and second with Fast Light closer to the center of this room to fill it with bounced ambient light. In this case, make sure to find such a range for Fast Light, which will make a visible gradient of intensity falloff from the center of the room to its corners (so corners could stay dark enough).



Ray-Traced GI

Ray-Traced GI. It is an addition to the basic light component. It takes in realtime all properties of basic light to add many small Fast Lights on the ends of bounced rays. To build bounced rays it creates a matrix of directions depending on the light type. For Spot Lights, it builds a regular grid of rays inside its cone. For Point Lights, it builds a spherical grid of rays to cover all its directions.

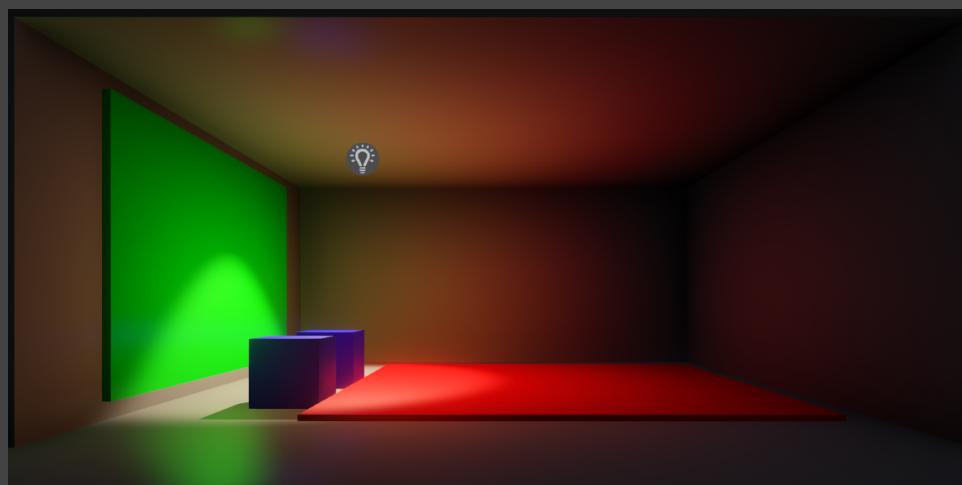


* **Intensity.** Multiplier - represents a percent of intensity that will be taken by bounced Fast Lights from the basic light source.

* **Rays Matrix Size.** This defines how many rays will be used in the matrix [N*N] to approximate the indirect lighting of this light source. E.g. for size 9 it will use 81 rays, for size 5 it will use 25 rays. In case if ray hits something, it will produce bounced Fast Light.

* **Soft Culling Distance.** If distance from current camera to light is greater than this - will be applied soft fading of all Fast Lights and basic light itself.

* **Hard Culling Distance.** If distance from current camera to light is greater than this - all Fast Lights and basic light itself will be fully disabled.



Ray-Traced GI - Best Practices

Rule - Use realtime Ray-Tracing, remember the result, then fake it manually.

When we want to gain extra performance, we could do such a design trick. First, we put highly detailed light with a crazy amount of rays for a better understanding of how GI propagates in this room/area. Then we just disable Ray-Tracing and approximate the final result by the manual placing a reasonable amount of Fast Lights.

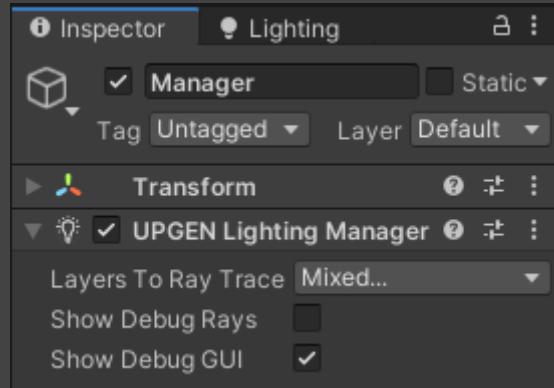
Rule - Use Ray-Tracing GI with Fast GI together for important lights.

Especially for Spot Lights it makes sense to combine both methods to get nice GI around starting part of the light cone with Fast GI and beautiful GI from the rest of the cone with Ray-Traced GI. Just try this with any lamps hanging on the ceiling. You will get beautiful light attenuation around the lamp on the floor from Fast GI and nice bouncing in the rest of the room from Ray-Tracing GI.



Manager

Manager. This is a global lighting preferences holder in the scene. It should be only one per scene. If absent - default values of all its properties will be used.



* **Layers to Ray-Trace.** Defines which layers would be used and ignored by a realtime ray-tracing. Usually, you need to ignore Player, Water, Inventory, UI, Triggers, and other types of special colliders.

* **Show Debug Rays.** Enables to see special lines, which represent bounced rays with Fast Lights on their end (in the Scene View).

* **Show Debug GUI.** Enables to see in top-left corner statistics about lights count of each type and Fast Lights capacity in post processing.



Limitations

- Only HDRP pipeline is supported (does not work with URP or Built-in pipeline)
- In automatic mode it could be very inaccurate (to stay fast) and some manual work still required
- Lighting does not affect forward-rendered objects like transparent geometry
- Ray-Tracing uses colliders to detect ray hits (geometry without colliders will not produce bounced lighting)
- Only light types supported with Fast GI and Ray-Tracing are Point and Spot Lights
- Does not take into consideration shadows and light cookies
- Ray-Tracing cache has a certain amount of inertia and will have visual delay for fast-moving light sources
- Ray-Tracing will produce light leaking
- Stereo rendering (XR) is not supported



Manual Setup Examples

Only Fast Lights. If light sources in the scene are static - we place hundreds of fast lights to approximate bounced lighting. If lighting is just switching - we can have two groups of fast lights for different states.



Mixed Setup Examples

Fast Lights used with basic lights. In this setup first we place real point lights with or without shadows (yellow icons) to approximate main lighting and Fast Lights (violet icons) to approximate bounced lighting.



Automatic Setup Example

Ray-Traced GI is used. In this setup first we place real point light with shadows (yellow icon) to approximate main lighting and Ray-Trace GI (you can see debug rays) to approximate bounced lighting which will react to changes of lighting in real-time.



F.A.Q.

What platforms does it support?

It should work on any platform. RTX video cards are not required to use Ray-Tracing components.

How to change the limit of Max Lights Count from 96?

You need to change constant «MAX_LIGHTS_COUNT» in two places - in the script (**UL_Renderer.cs**) and in the shader (**UPGEN Lighting.shader**). However, be careful - making it too high can affect performance, try to keep this limit as low as possible.

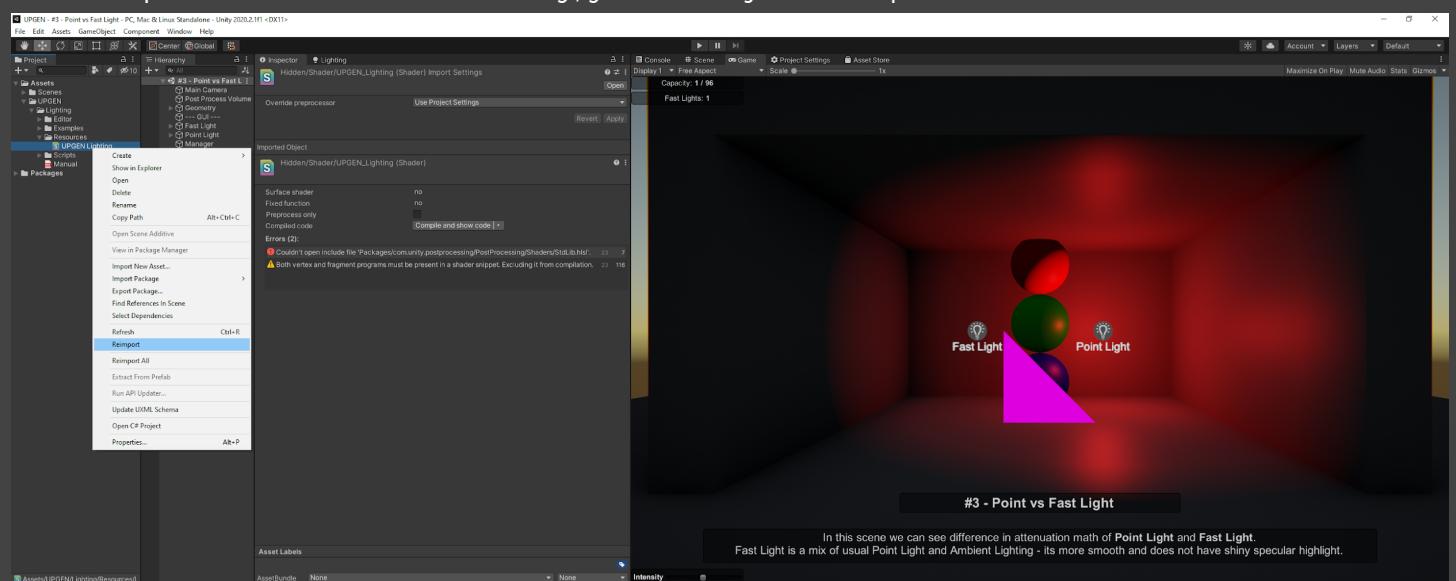
How would this work for procedural levels? First/third person cameras?

It is fully runtime, so it is a perfect solution for such cases. It does just what you are expecting if you provide colliders to your geometry. As for cameras - you can use any kind of view you want.

How to make Ray-Tracing to ignore trigger colliders?

For performance reasons there is no special logic in code to ignore colliders with a trigger flag. To make it work properly just put such colliders on a special layer and set the LayersToRayTrace mask of the Manager component to ignore all unwanted layers.

If you are experiencing "**pink triangle**" problem - this happens because Unity did not compiled shader code correctly, you need just reimport it



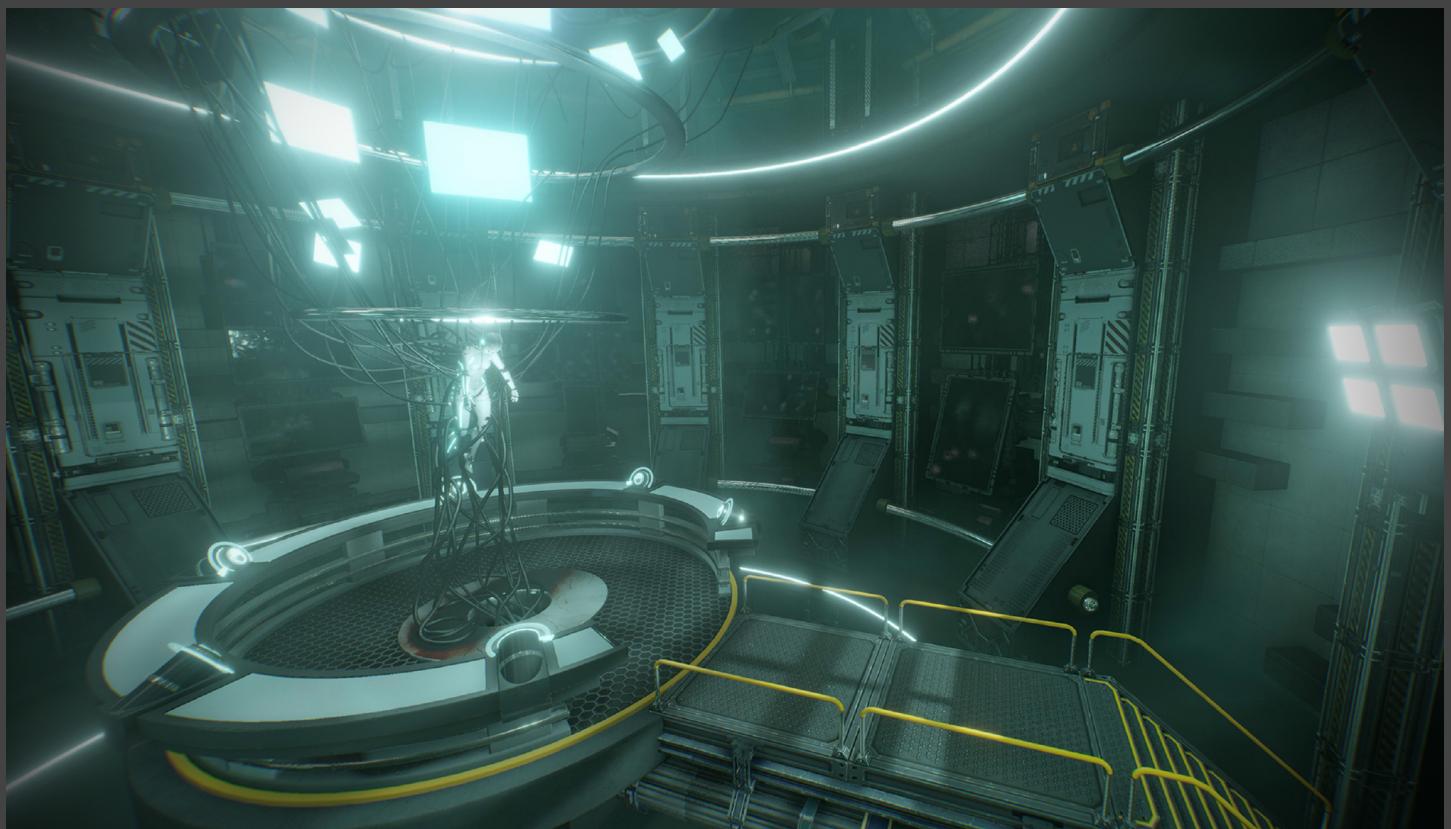
How can I bake bounced lighting into Reflection Probes?

Before baking reflection probes you can substitute UPGEN lighting with a set of Point Lights. To do this you should create a Manager component (somewhere in the scene) and press the "Generate Point Lights" button. After baking you can delete them by pressing the "Destroy Point Lights" button.

Feedback & Support

If you need help with UPGEN Lighting or would like to share your feedback and experience or want to report an issue - you can visit the thread on the Unity Forums or you can email me at anton.tril@gmail.com.

If you are reporting an issue, please provide a detailed description of the problem you are experiencing, screenshots, and system information (graphics card, operating system, Unity version, etc.).



Changes Log

v2.0

- Fast Light: added Subtractive feature
- Fast Light: added Soft Culling feature
- Fast GI: added Soft Culling feature
- Ray-Traced GI: added Soft Culling feature
- Ray-Traced GI: removed support of Directional Light
- Framework: removed stereo-rendering support
- Framework: increased overall performance

v1.6

- Manager: new button to Create/Destroy set of Point Lights from internal rays
- Ray-Traced GI: Increased Maximum value of RaysMatrixSize from 15 to 25

v1.5

- Added “ClearCache” method for rays cache
- Auto selection after creation on new objects from main menu
- Bug fixes

v1.4

- Added Ray-Traced GI rays smoothing for fast moved Fast Lights

v1.3

- Added main menu commands to create Fast Light and Manager objects
- Updated script icon for Manager script

v1.2

- Ray-Traced GI: when used with Directional Light new property “Rays Matrix Scale” can adjust scale of ray-tracing matrix (how big area should be covered by rays)

v1.1

- Ray-Traced GI: new button to Create/Destroy set of Fast Lights from internal rays
- Examples: hide next/prev buttons if you have no scenes in build settings
- Manual: quality improvements + size reduced